INTRODUCTION

In this tutorial you will use 3D Studio Max 6 and reactor to set up a physics simulation. Using these animation tools you will create a wrecking ball (swinging chain with heavy ball on the end used to break things, see figure 1). This tutorial will touch on some of the key elements to remember when using reactor. After completing this tutorial you will be able to create chains and hopefully you will avoid common mistakes that often frustrate people when using these techniques. This tutorial will give you the knowledge to explore and experiment with most of the reactor tools. If used properly, reactor is a powerful tool.
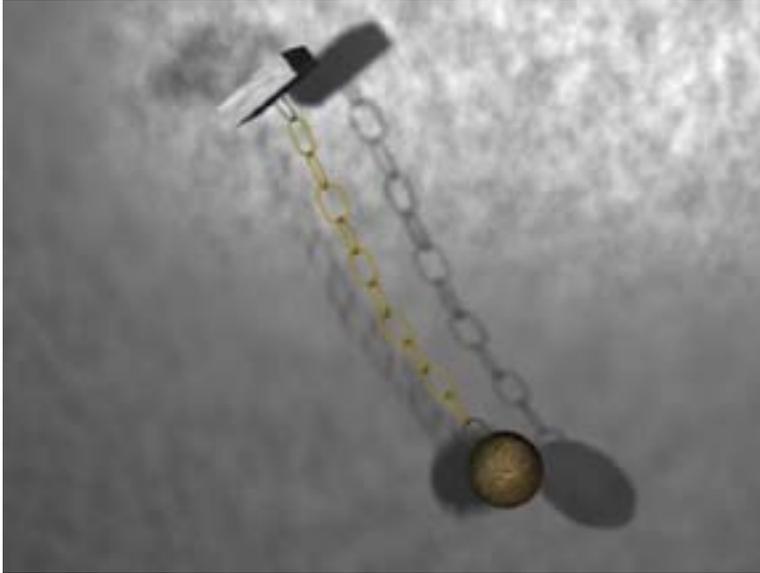

Figure 1. Finished rendered picture

WARNING! THIS TUTORIAL ASSUMES YOU KNOW THE INTERFACE AND WORKINGS OF 3D STUDIO MAX 6. THIS TUTORIAL IS FOR EXPERIANCED 3D ANIMATORS.

To Get Started: It Only Takes One, Create the Chain-Link

Step 1. Open 3D Studio Max 6, or if it is already open, reset the scene.

Step 2. To start, draw a Torus in the front view-port. Radius 1 should be 60. Radius 2 should be 6. Use 26 segments and 15 sides. The parameter's roll out should look like figure 2.
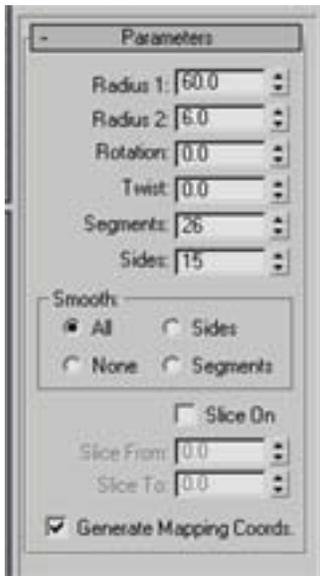
Figure 2. Parameter box

Step 3. Now convert the torus into an editable poly and activate the vertex sub-object.

Step 4. Now drag-select the top half of the torus. This will select the vertices on the top of Torus01. Select the move tool. Move these vertices up to create the shape of a chain link. In the picture below the vertices were moved 72 units up. See Figure 3 for an example of this step.
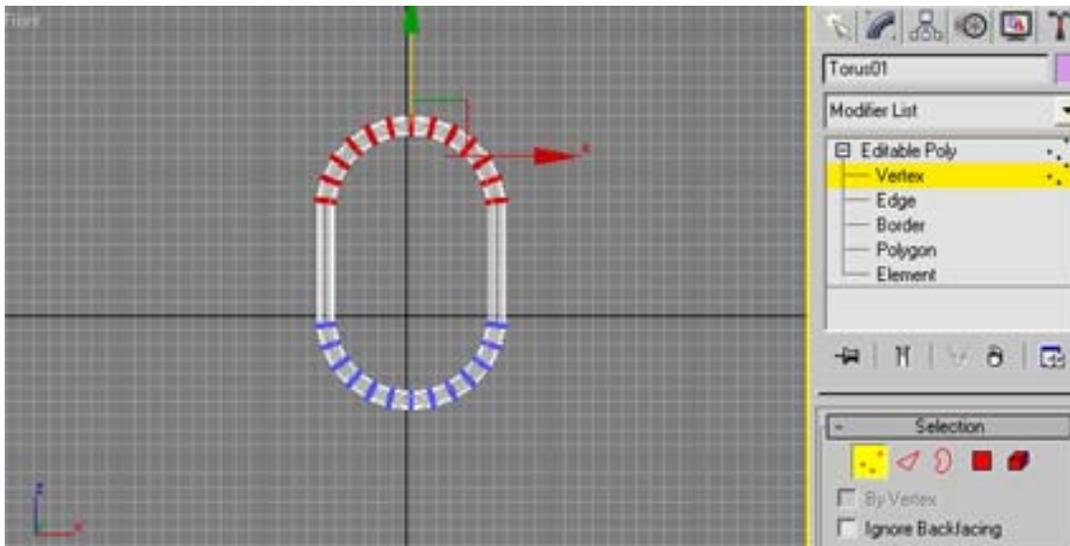
Figure 3. Front view

Step 5. Select the editable poly for Torus01 to return to the top level. In the front view-port place the chain-link you just created in the top center. This will give you space to clone the other links below the first one.

Now Make Some Clones

Step 6. The chain-link should still be active and this step also uses the move tool. With your cursor over the green Y-axis, **Shift**-drag down to make a clone. The Clone Options box pops up and asks some questions. Select Copy from the Clone Objects box and put in 6 for the Number of Copies. Click OK and you should now have six clones and seven chain-links total. See figure 4 below for help.
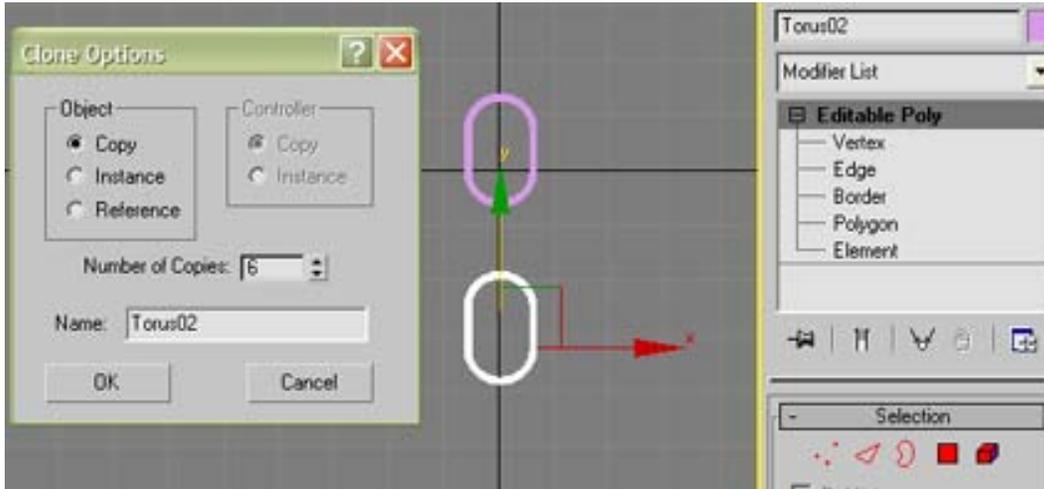

Figure 4. Cloning Options

Step 7. Now you will clone these seven links to make the other half of the chain. Zoom out of the front view-port so you can see all seven chain-links. Select all of the links.

Activate the object rotation mode and **Shift**-drag on the horizontal axis 90 degrees. This move will clone all seven original links and rotate them into the position we need. See Figure 5 for an example of this step.
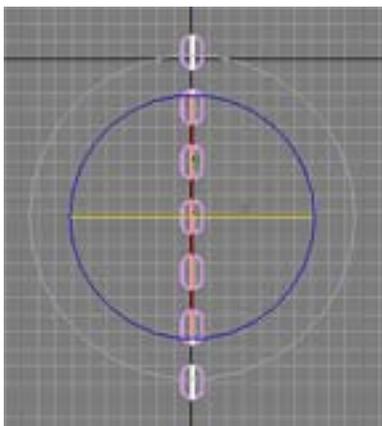

Figure 5. Rotated clones

Step 8. All of the new clones should be selected, if they are not, then select them now.

With the move tool ⊕ drag the cloned links down to form the basic chain. Take a minute and give the chain extra breathing room. This means give the links more space so they are not even close to touching. See before (figure 6.) and after (figure 7.) pictures below.
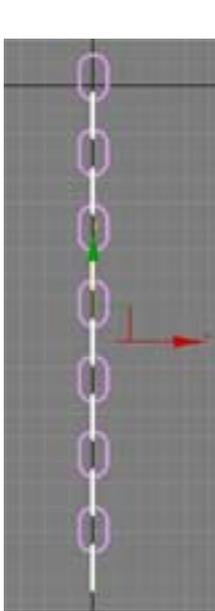

Figure 6. Front view before   Figure 7. Front view after

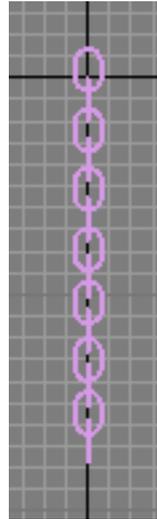## Time To Add the Wrecking Ball and Anchor

Step 9. The wrecking ball is going to swing from an anchor point or a fixed point in space. Create this by making a box and moving it to the top-most link in the chain. The box is then converted into an editable-poly and attached to the top link of the chain. Figure 8 below shows the result of this step.
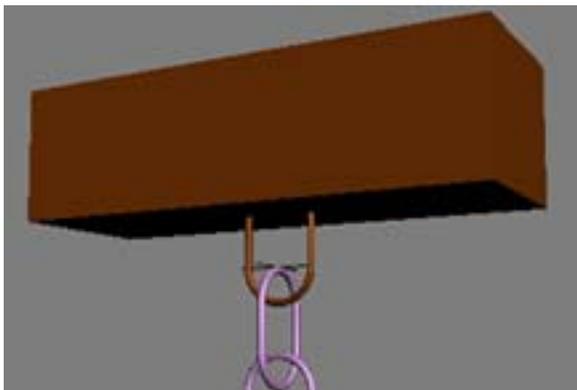

Figure 8. Anchor box attached to top link

Step 10. This is when you create the business end of the wrecking ball. Create a sphere in the top view-port centered to your chain pieces. The sphere pictured below has a radius of 250. Convert this shape into an editable-poly and position it at the bottom of your chain. Use the align tool if you want it to be perfect. Attach the sphere and the modeling is complete. See Figure 9.

Figure 9. Wrecking ball attached

WARNING! YOU STILL HAVE NOT ADDED HIP METAL TEXTURES, DO THIS NOW!

It's Physics Time

Now it is time to run the wrecking ball through the physics based key-frame generator know as reactor. The 3D Studio Max 6 reference guide describes reactor as, "a plug-in for **3ds max** that allows animators and artists to easily control and simulate complex physical scenes. **Reactor** supports fully integrated rigid and soft body dynamics, cloth simulation, and fluid simulation. It can simulate constraints and joints for articulated bodies. It can also simulate physical behaviors such as wind and motors. You can use all of these features to create rich dynamic environments". (3d studio max reference guide, release #6. Feb.03)

Step 11. In a few short and easy steps you will have this ball swinging. In this tutorial you will use a rigid body collection. This is the tool used to simulate rigid objects such as; bricks, bullets, wood and chain-links. The soft body collection is used for soft items like; flags, clothes and beanbag chairs.

To start this step, select all the elements in the scene. The Select by name tool is handy for this.   The keyboard shortcut for this is (h). If it is not yet in you skills set, take

a look at it. This tool opens up a dialog box when used and allows you to select objects from your scene using an organized list. See Figure 10.

Figure 10. Select by Name Dialog box

Step 12. With all the items in the scene selected you can create the rigid body collection and all the pieces will be automatically added. This is important to remember when using reactor; it will save you a lot of time. All of the elements that you want reactor to recognize in the scene must be in the reactor rigid body collection.

Select the rigid body collection button and click in the scene anywhere is ok. The rigid body collection is also available at the top of the screen in the reactor drop-down window. To access the rigid body collections this way click on reactor, hold over create object and select rigid body collection. See Figures 11 and 12 for both examples.
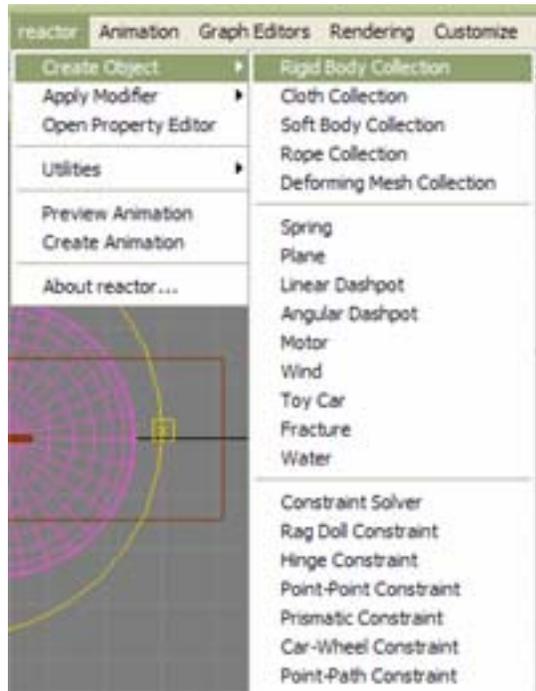
Figure 11. Top box is the Rigid Body Collection

Figure 12. Reactor drop-down window

Step 13. You should now have a rigid body collection in your scene that contains all your

elements. To confirm this select the icon in your scene like this and click on the
modify tab panel. You can see the items from the scene in the scrolling box; it should
look like Figure 13.

Figure 13. Modify Panel Rigid Body Collection

Step 14. Now give the chain links and the wrecking ball some mass. This will allow the
objects to fall realistically and it is one of the main properties in the simulation. First
select the links of chain with the selection tool. Open the reactor properties in the utilities

drop-down menu. Open properties and set the mass of the chain links to 20. Set elasticity and friction to 0. In the simulate Geometry box select use mesh.

WARNING! ALL THE ELEMENTS IN THIS TUTORIAL MUST BE SET TO "USE MESH" IN THE SIMULATE GEOMETRY BOX

Why use mesh only? **Explained by 3d studio max**
Convex and Concave Objects
A rigid body primitive is defined as convex if, given any two points inside the object, you can always go in a straight line from one to the other without leaving the object. Convex objects include spheres, cylinders, and boxes. For example, a sphere is convex but a golf ball is concave because of the concavities (dimples) in its surface. Also, by definition, non-closed meshes (planes, hollow hemispheres) are always concave.

Convex objects are faster to replicate than concave objects. Because of this, you should aim to use convex objects as often as possible for simulation. Treating concave objects as convex for simulation purposes allows you to take advantage of their faster processing time. This is the default setting for an object's simulation geometry (Mesh Convex Hull). If you are unsure whether an object is convex or concave, you can perform a convexity test on it. With the object selected, open the reactor - Utilities menu and select Convexity Test.

 Concave Mesh— The actual mesh of the object is used for simulation. It should be noted that though the convex hull of an object and the object's actual mesh may be exactly the same, using the convex hull will result in a simulation which runs much more quickly, as **reactor** can make certain assumptions for convex objects. If you try to use Concave Mesh for a convex object you will get a warning. Not heeding such warnings could dramatically reduce the speed of your simulation. There are some cases, though, we you may want to ignore that warning; for example, if you want to place objects *inside* a convex object, and make them collide with the internal faces of that object, you should simulate it as concave instead of convex. (3d studio max reference guide, release #6. Feb.03) The built-in, user reference, is an amazing resource and has answered many questions for me.

Step 15. Repeat step 14 on the wrecking ball but set the mass of this ball to 250 units.

Step 16. For the anchor box at the top of the chain it must be set to use mesh, but do not give this object any mass. If this object has no mass it will stay in place during the simulation but interact with the chain connected to it. This is the desired effect we are looking for.

Almost Magic Time

Step 17. To give the wrecking ball potential energy and a good starting position rotate it about 35 degrees to the side. See Figure 14 below for example.
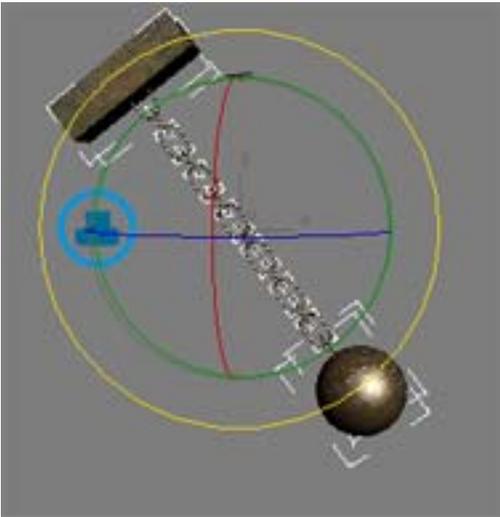
Figure 14. Wrecking ball in start position

Step 18. Open up the preview and Animation dialog box and the world dialog box. Use the settings from the list below to get this set-up fast.

- Set the end frame to 200.
- Set the sub steps and keys to 40.
- Use 1.2 as the time scale in this menu.
- Set the Col. Tolerance (collision tolerance) to 0.5.

Step 19. Add 100 keys to the timeline. To do this the easy way ctrl + alt + right click in the timeline on the bottom of the interface. Now drag left to add keys. Cool trick, right? Now you can enjoy this movie for twice as long.

Step 20. Create the animation; the button is in the preview and animation menu. The button is labeled **Create the animation**. If you get any error messages, you messed up. Just kidding, sometimes you get an error message stating "the objects do not have real world mass" but, if you run the simulation, it will work. You might need to adjust the mass for a realistic effect. If you get an error message stating that an object is inner-penetrating another object you have two objects touching or items not set to use mesh in the reactor settings. (Step 13) Otherwise you should now have a swinging wrecking-ball.

Reactor has helped me answer the question asked by Edward Tufte(1990). "How are we to represent the rich world of experience and measurement on mere flatland?" (p.65). I answer this question with my attention to detail and time saving, mathematically accurate, tools such as reactor. I encourage people to explore all of reactor's tools.

References:

Discreet. (2004) <u>3d studio max reference guide</u> release 6.

Tufte, R. E. (1990). <u>The visual display of quantitative information</u>, Cheshire, Cn Graphics Press. (p.65)